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# (54) Configuring functional units in a serial master-slave arrangement

(57) Several slave units 1, 2 of a master-salve configuration are connected in series, the slave units 1, 2 are each equipped with two pairs of input/output units and with a digital computer 10, 11, an electronic switch 25, 26 being provided between a receiving unit 16, 19 located in a direction coming from the master unit 6 and a neighbouring slave unit 2 being more remote from said master unit 6, the control input 27, 28 of said electronic switch being connected to the digital computer 10, 11. In each slave unit 1, 2 there is provided an electronic signal-summing element 29, 30, a first input of said signal-summing element being connected to the digital computer 10, 11, preferably via an interface circuit, and a second input of said signal-summing element being connected to a receiving section 17, 19 of the input/output unit receiving signals from said neighbouring slave unit provided more remote from the master unit 6.

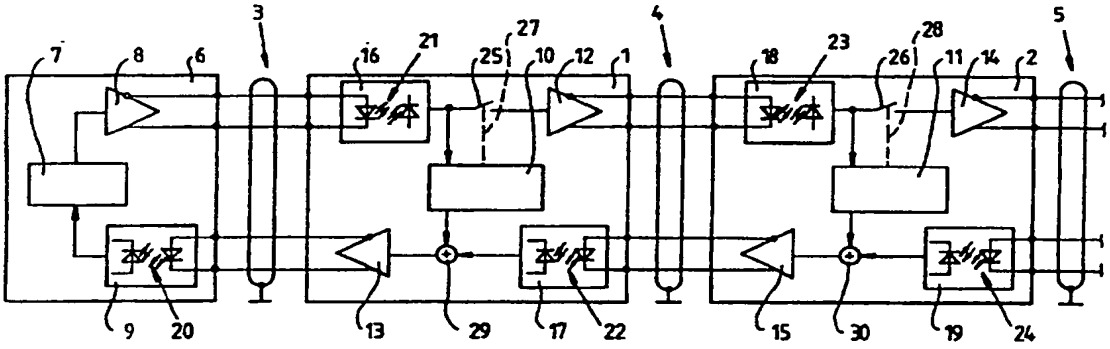


Fig.1

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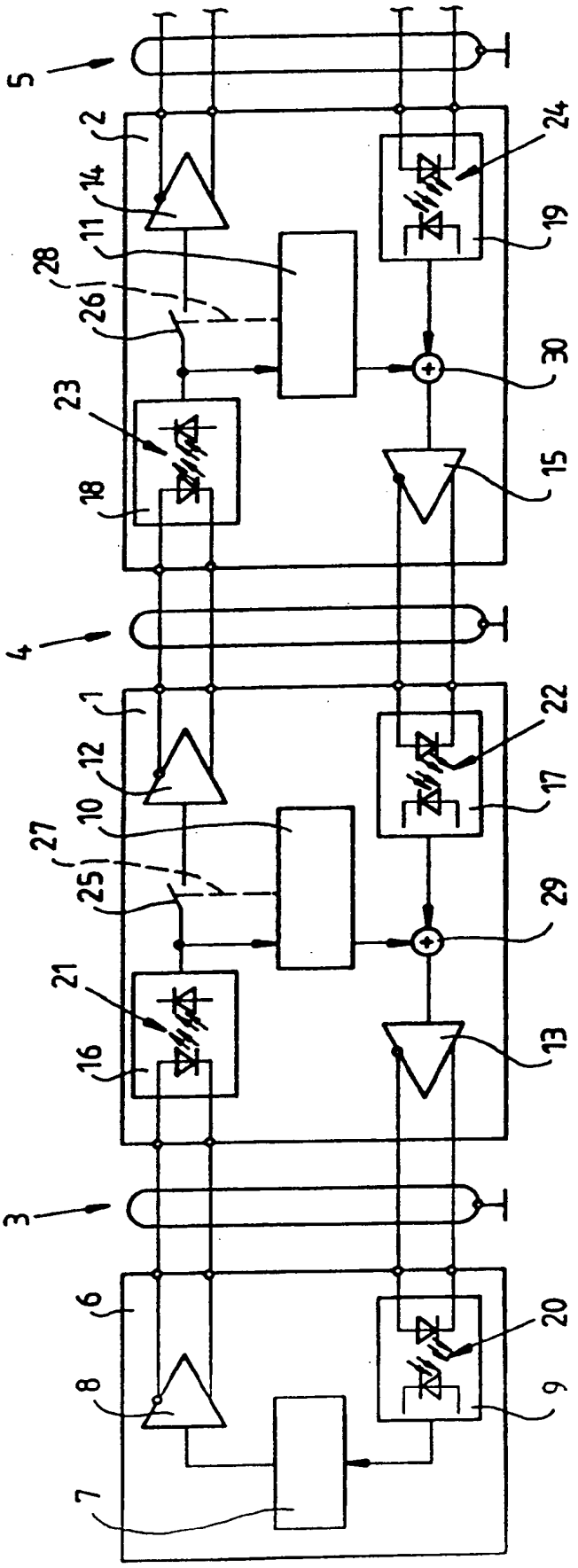


Fig.1

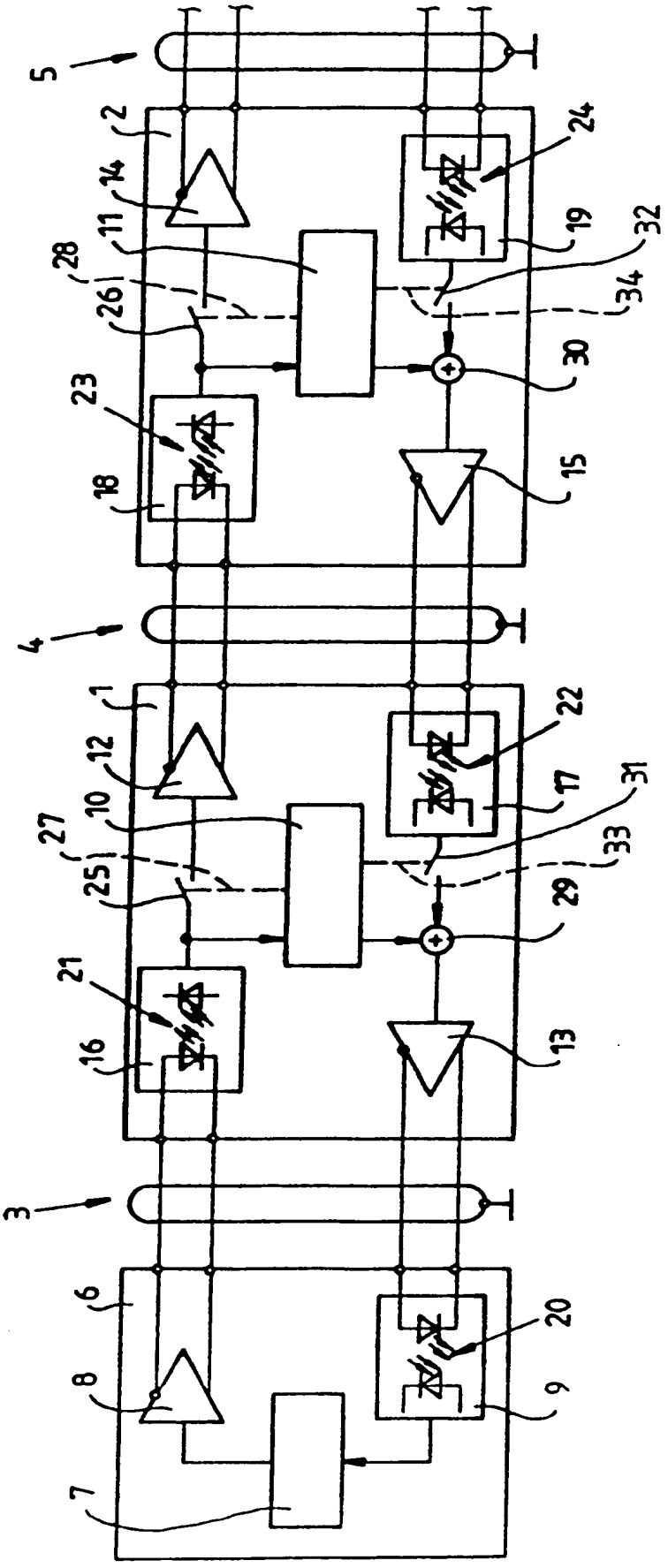


Fig. 2

# Method of and arrangement for configuring functional units in a serial master-slave arrangement

The invention relates to a method and an arrangement for the transfer of information or other signals between a plurality of functional units cooperating in a master-slave configuration.

It is known to connect, for the transfer of information, a master unit and at least one slave unit to a common bus system in order to transfer information. For this purpose specific circuits controlling the transfer of data between master unit and slave units are provided in said master unit and said slave units. The fact that said specific circuits are expensive is disadvantageous.

Furthermore, it is known to provide a master unit with a plurality of serial interfaces making it possible to connect a respective intelligent slave unit equipped with a computer to each of said interfaces. For each additional slave unit to be connected to the master unit an additional serial interface has to be provided, said additional serial interface requires material, is expensive and enlarges the volume occupied by the master unit.

The possibility of connecting a plurality of slave units to a serial interface is restricted by the performance of the line-drive components in the master unit. To equip the master unit with specific high-performance driver components is cost-increasing because such components are not commercially available and thus require individual developments, or because only small quantities of said components are manufactured. Moreover, when connecting in parallel a plurality of slave units to a serial interface of the master unit, each slave unit has to be addressed by means of hardware elements by, for example, providing a number of switches in the slave unit so as to form a certain

configuration. According to this procedure it is, however, not possible to design similar slave units so as to be identical with respect to hardware and software so that said slave units could be easily exchanged for the purpose of addressing them, if necessary, which would guarantee low manufactoring costs and service costs.

It is also known to connect a plurality of slave units in series by means of data-transfer lines, a slave unit located at the end of the serial arrangement being connected to a master unit. The master unit features one serial input/output unit, whereas the slave unit has two serial input/output units. With these solutions, too, the slave units are addressed by means of hardware elements, i.e. switches or solder straps, having the aforementioned disadvantages.

It is the object of the invention to develop an arrangement for the transfer of information or other signals, said arrangement permitting the linking and addressing of a plurality of slave units connected in series to a master unit easily and at low-cost.

According to the invention this object is achieved in that in an arrangement in which a plurality of slave units of a maste-slave configuration is connected in series, that the slave units are each equipped with two pairs of input/output units and a digital computer, an electronic switch being provided between a receiving unit located in a direction coming from the master unit and a neighbouring slave unit located towards said master unit but more remote remote therefrom, the control input of said switch being connected to the digital computer. Furthermore, the invention consists in that each slave unit is provided with an electronic signal-summing element, a first input of said electronic signal-summing element is connected to the digital computer, preferably via an interface circuit, and that a second input of said electronic element is connected to a receiving section of the

input/output unit receiving signals from the aforementioned neighbouring slave unit which is provided more remote from the master unit. Due to the summing element only the active signal of the respective digital computer or the neighbouring slave unit is transmitted at the output of said slave unit in direction of the master unit. The electronic switch and the summing element may be set up of different logical elements. For example, the switch may be an AND element, and the summing element may be an exclusive OR element.

The invention is to be explained in greater detail with reference to a specimen embodiment.

Fig. 1 is a schematic view of the inventive arrangement, and

Fig. 2 shows a specimen embodiment of a slave unit.

As shown in Fig. 1 a plurality of similar slave units 1, 2 are connected in series by means of multi-core cables 3, 4 , 5, the slave unit 1 located at the end being connected to a master unit 6. Said master unit 6 comprises a digital computer 7 as well as an output unit 8 and an input unit 9, said output unit and said input unit each being connected to the digital computer 7. The slave units 1, 2 each comprise further digital computers 10, 11, two output units 12, 13, 14, 15 and two input units 16, 17, 18, 19. Via cable 3 the ouput unit 8 is connected to the input unit 16, and the output unit 13 is connected to the input unit 9. The cable 4 provides a connection betweeen the output unit 12 and the input unit 18 and between the output unit 15 and the input unit 17. By means of cable 5 the output unit 14 and the input unit 19 are connected to further input/output units (not illustrated) of further slave units. With respect to the galvanic separation the input units 9, 16, 17, 18, 19 comprise optocouplers 20, 21, 22, 23, 24 the LEDs of which are each connected to two cores of the cables 3, 4, 5. The slave units 1, 2 comprise electronic switches 25, 26 to interrupt the connection between the input units 16, 18

and the output units 12, 14. The control inputs of the switches 25, 26 have a respective connection 27, 28 with respect to the digital computers 10, 11. Furthermore, the slave units 1, 2 comprise summing elements 29, 30, the first summing inputs of said summing elements are connected to the digital computers 10, 11, and the second summing inputs of said summing elements are connected to the outputs of the input units 17, 19, whereas the summing ouputs of said summing elements are connected to the inputs of the output units 13, 15.

The inventive method may be implemented by means of this arrangement as described hereinafter: Due to the fact that master unit 6 and slave units 1, 2 are connected in series, each slave unit 1, 2 comprises two interfaces each of which is suitable for the transfer of signals to and from the slave unit 1, 2 and to and from the master unit 6 respectively. The digital signals entering the input units 9, 16, 18 are processed and supplied to the respective digital computer 7, 10, 11 for evaluation. Depending on the fact as to whether the switch 25, 26 is closed, the digitized signals are transmitted, via the output unit 12, 14 of the respective slave unit 1, 2, to the following slave unit 2 connected. If all switches 25, 26 are closed, a signal transmitted by the master unit 6 may be received by all slave units 1, 2 connected. Vice versa, a signal transmitted by any slave unit 1, 2 may be supplied to the master unit 6, provided the digital computer 10, 11 does not produce any signal at the summing input of the respective summing element 29, 30 so that the signal transmitted by a slave unit 1, 2 in direction of the master unit 6 may pass in an unchanged manner the summing elements 29, 30 in the slave units 1, 2 located on the signal path. This may be achieved by keeping strictly to the master-slave principle, i.e. that the respective slave unit 1, 2 only transmits signals if prompted by the master unit 6 to do so. The digital computers 10, 11 of the slave units 1, 2 are programmed such - or, in other words, the hardware is designed such - that they are able to recognize a sychronizing sequence

among the flow of data coming from the master unit 6 or the preceding slave unit 1 and to receive a data set. Preferably, in each data set said synchronizing sequence is directly followed by an address byte for addressing a slave unit 1, 2. Via the digital computers 10, 11 all slave units 1, 2 check as to whether said address byte corresponds to the respective address. If there is no correspondence, the data reception is interrupted until the next synchronizing sequence. In the case of an address correspondence, the respective slave unit starts to process the data. The slave units 1, 2 have an identical list address defined by the hardware. Furthermore, via said data set, an individual address may be assigned to each slave unit 1, 2.

With respect to initialization of and address allocation to a slave unit 1, 2 the master unit 6 transmits a command to open the switch 25, 26, having been closed beforehand, by means of the list address. Thus, all slave units 1, 2 prevent that the signal is supplied to the neighbouring slave units 1, 2. Upon this command the slave untis 1, 2 do not transmit a reply in direction of the master unit 6. In a further step the master unit 6 transmits a first command to individually allocate addresses by means of the list address. Due to the switches being open, only the first slave unit 1 directly connected to the master unit 6 receives said command. The digital computer 10 stores the address allocation and, via the summing element 29 and the output unit 13, supplies a defined reply to the master unit 6 that the individual address has been allocated. Furthermore, via the connection 27, the digital computer 10 causes the switch 25 to be closed.

The master unit 6 checks the defined reply and causes a re-initialization, if the reply is not correct. If the reply is correct, and if not all slave units 1, 2 stored in the master unit 6 have yet been initialized, a further command for individual address allocation by means of the list address is supplied, said command being received by the slave unit 2 which

does not yet have an individual address. The initializing is repeated for each slave unit 2 according to the initialization of the first slave unit 1. The initialization is completed, if all slave units 1, 2 have stored the individual addresses and the slave units 1, 2 have successively transmitted a correct reply to the master unit 6.

In all cases in which, with respect to the transfer of data involving a slave unit 1, 2, a master unit 6 reports an error which could not be eliminated although the commands have been repeated several times, the connection in the slave units 1, 2 has to be set up again by the master unit 6.

According to the modification of the invention shown in Fig. 2 a respective further electronic switch 31, 32 is provided between the second summing input of the respective summing element 29, 30 and the input units 17, 19, the control input of said switch features a connection 33, 34 to the digital computers 10, 11. Thus, interferences can be suppressed by the fact that several slave units 1, 2 transmit signals simultaneously. While the slave unit transmits signals itself, a reply of the slave unit 1, 2 being transmitted in direction of the master unit 6 could prevent the summing of signals in the summing elements 29, 30 of the slave units 1, 2 being located more remote from the master unit 6. Thus, the slave unit 1, 2 nearest to the master unit has top priority.

C L A I M S

1. Method of configuring functional units in a serial master-slave arrangement,
said functional units being provided for the bidirectional transfer of digital data between a master unit and a respective slave unit,
method in which the master unit allocates a respective address to each slave unit which, when being in a non-configured condition, has no individual address,
characterized
by processing the following method steps:

a) a record A is transmitted from the master unit to a list address, said record causing a switch to be opened in each of the slave units, said switch interrupting the transfer to the neighbouring slave units and resetting the memory for an individual address in each slave unit;

b) a further record B is transmitted from the master unit to the list address, said record allocating an individual address, determined by the master unit and included in the record B, to each of the receiving slave units, if in the slave unit the memory for the individual address is still in its reset condition,

c) upon allocation of the individual address the respective slave unit acknowledges said allocation by transmitting an acknowledgement record to the master unit, and said switch is closed;

d) upon receipt of the acknowledgement record the master unit transmits a further record with a further individual address to the list address;

e) the method steps b) through d) are repeated until a respective individual address has been allocated to each slave unit; and

f) if an acknowledgement record transmitted in method step c) has been received by the master unit incorrectly or not at

all method steps a) through e) are repeated until the acknowledgement signal sent by each of the slave units has been correctly received by the master unit.

2. Arrangement for configuring functional units in a master-slave arrangement,
comprising a master unit having a digital computer and an input/output unit,
and comprising a plurality of slave units each having a digital computer and two input/output units,
whereby the master unit is connected to a first slave unit, and the slave units are connected to each other in series via the input/output units and data-transfer lines,
characterized in

- that in each slave unit (1, 2) there is provided an electronic switch (25, 26) for blocking the transfer of data between a receiving section (16, 18) - receiving information or signals from the direction of the master unit (6) - of the input/output unit and a transmitting section (12, 14) of the input/output unit driving information or signals in direction of neighbouring slave units (2), and
- that in each slave unit (1, 2) there is provided an electronic summing element (29, 30),
a first input of said summing element being connected to the digital computer (7), and a second input of said summing element being connected to a receiving section (17, 19) of the input/output unit receiving the signals from the neighbouring slave unit (2) provided more remote from the master unit (6), and
- the output of said summing element being connected to a transmitting section (13, 15) of the input/output unit connected in direction of the master unit (6).

3. Arrangement according to Claim 1,
characterized in
that between summing element (29, 30) and receiving section (17, 19) there is provided a further electronic switch (31, 32) the control input of which has a connection (33, 34) to the digital computer (10, 11).

LIST OF REFERENCE NUMERALS

| | |
|---|---|
| 1, 2 | slave unit |
| 3, 4, 5 | cable |
| 6 | master unit |
| 7 | digital computer |
| 8 | output unit |
| 9 | input unit |
| 10, 11 | digital computer |
| 12, 13, 14, 15 | output unit |
| 16, 17, 18, 19 | inputunit |
| 20, 21, 22, 23, 24 | optocoupler |
| 25, 26 | switch |
| 27, 28 | connection |
| 29, 30 | summing element |
| 31, 32 | switch |
| 33, 34 | connection |

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

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(ii) Int Cl (Ed.6) H04L 12/40, 12/12; G06F 12/06; H04Q 9/14

Search Examiner
MR J P COULES

Date of completion of Search
26 APRIL 1995

**Databases** (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1-3

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

| Category | Identity of document and relevant passages | | Relevant to claim(s) |
|---|---|---|---|
| X | EP 0281534 A2 | (INSINOORITOIMISTO BERTEL EKENGREN OY) see whole document | 1 and 2 |
| A | US 4723241 | (US PHILIPS CORP) see whole document | 1 and 2 |

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